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NATIONAL AIR INTELLIGENCE CENTER

CARRIER ROCKETS OF THE WORLD:
TSYKLON (RUSSIA/CIS)

by

Li Shuangqing

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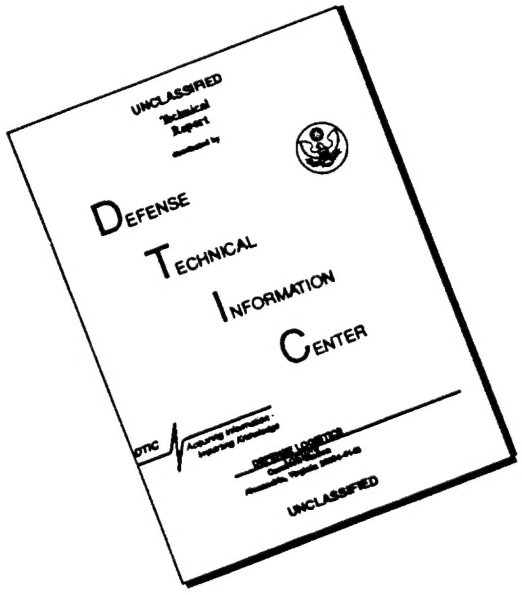

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Zhongguo Hangtian (*China Aerospace*) Number 10, 1995

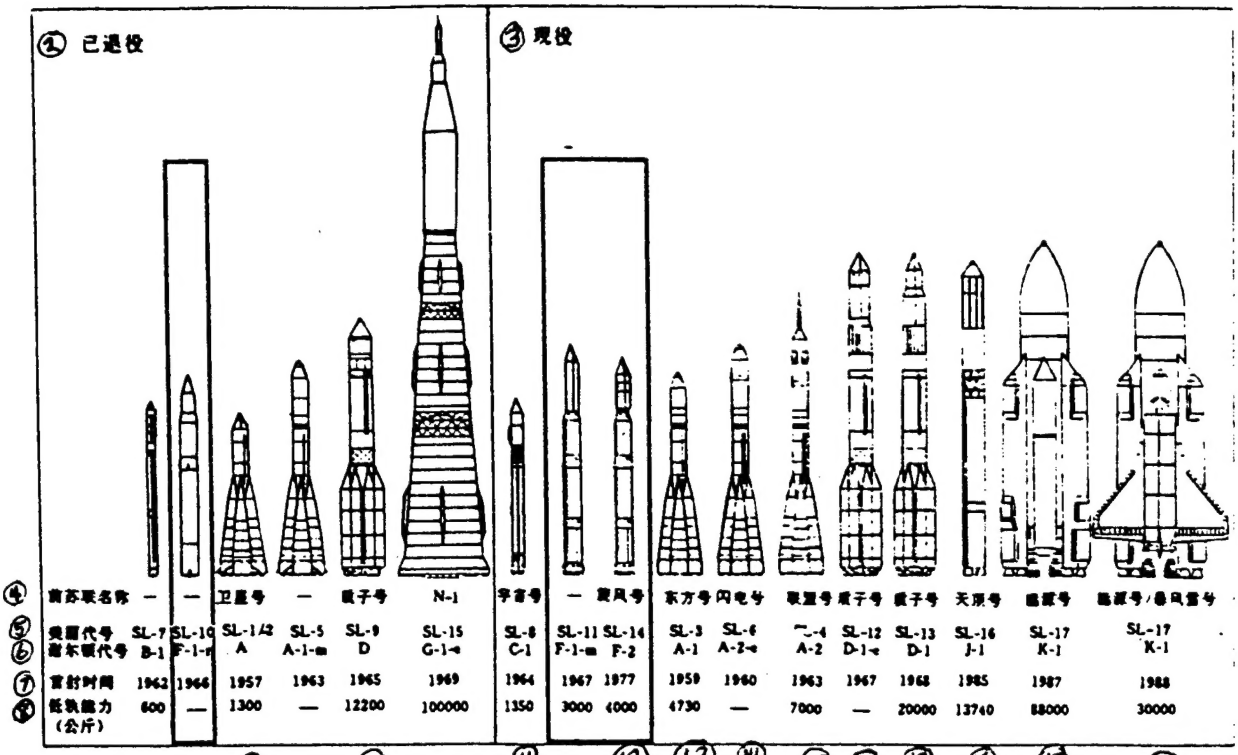
Carrier Rockets of the World: Tsyklon (Russia/CIS)

Author: Li Shuangqing

The Tsyklon was developed in the mid-1960s based on the SS-9 [Scarp] ICBM. It belongs to the Sheldon system's F family of medium-sized carrier rockets. Of these, the F-1-r (SL-10 Tsyklon 1) has been retired, and the F-1-m (SL-11 Tsyklon 2) and F-2 (SL-14 Tsyklon 3) are still in service. The load capacity of the Tsyklon carrier rocket is greater than that of the Cosmos but less than that of the Soyuz rocket, and thus it fills the gap in load capacity between these two and makes the former Soviet Union's carrier rocket series more complete.

The Tsyklon carrier rocket was developed by the Yangel design bureau (now Ukraine's NPO Yuzhnoye). The SL-10 was a two-stage liquid propellant carrier rocket, and was originally a component of the former Soviet Union's outer space weapons program, the Fractional Orbit Bombardment System (FOBS). The "r" in its Sheldon code name stands for its retro-rocket stage. This carrier rocket was launched for the first time on September 17, 1966 from the Baikonur [Tyuratam] Cosmodrome and ended service in 1972. All that were launched carried military and experimental payloads.

The SL-11 is also a two-stage liquid propellant carrier rocket, and was originally used as part of the former Soviet Union's anti-satellite weapon program. The "m" in its code name refers to its maneuverable stage, which indicates primarily satellite interceptors and radar and electronic ocean reconnaissance satellites [as per text]. This rocket is 43.3 meters tall, has a diameter of 3 meters, a launch weight of 180 tons, and a launch thrust of 2747 kilonewtons. It has a fairing 14.14 meters tall with a diameter of 2.13 meters. The SL-11 was launched for the first time from the Baikonur launching site on



① 图 1 前苏联的运载火箭家族

Key: (1). Figure 1 Carrier rocket families of the former Soviet Union. (2). Retired. (3). In service. (4). Former Soviet name. (5). United States code name. (6). Sheldon code name. (7). Year of first launch. (8). Low orbit capacity (kilograms). (9). Sputnik. (10). Proton. (11). Cosmos. (12). Tsyklon. (13). Vostok. (14). Molniya. (15). Soyuz. (16). Zenit. (17). Energia. (18). Energia/Buran.

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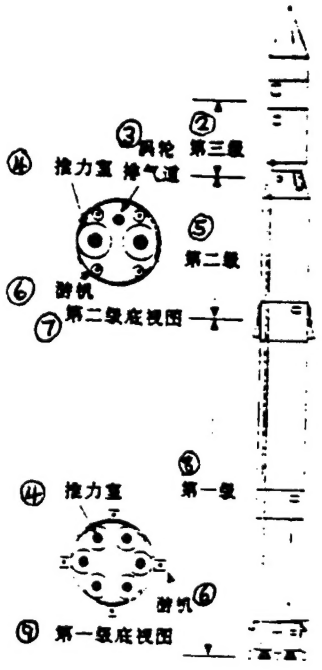
October 27, 1967, and has been in service for the past 28 years.

A third stage was added to the SL-11 rocket to make the SL-14, a three-stage liquid carrier rocket. Although it is no longer under the command of the former Soviet Union's outer space weapons program, it still primarily launches military payloads. This rocket has a height of 39.27 meters, a diameter of 3.0 meters, a launch mass of 189 tons, and a launch thrust of 2747 kilonewtons. The first stage is 21.14 meters long and 3.0 meters in diameter. Its engines are

RD-218 liquid propellant engines developed by the Glushko design bureau (now NPO Energomash) with six combustion chambers. In addition, the first stage has four gimballed vernier engines developed by NPO Yuzhnoye. The first, second, and third stages all employ unsymmetrical-dimethyl hydrazine/nitrogen tetroxide (UDMH/NTO) propellant.

The second stage is 8.0 meters long, also has a diameter of 3.0 meters, and has Glushko design bureau RD-219 liquid propellant engines (possibly improved models), two fixed combustion chambers, and four vernier engines (produced by NPO Yuzhnoye).



① 图2 SL-14 旋风 3 运载火箭的外形结构

Key: (1). Figure 2 External structure of the SL-14 Tsyklon 3 carrier rocket. (2). Third stage. (3). Turbine exhaust duct. (4). Thrust chamber. (5). Second stage. (6). Vernier. (7). Second stage – bottom view. (8). First stage. (9). First stage – bottom view.

The third stage has a length of 2.58 meters and a diameter of 2.25 meters, and is installed in the fairing together with the payload. Its engine is produced by NPO Yuzhnoye and can be

started three times. By starting multiple times, it can send multiple payloads each into their own orbits. The fairing is 10.13 meters tall, 2.7 meters in diameter, has a payload volume of 19 square meters, and can hold one or more payloads. At launch, its peak longitudinal overload is 12 g and its peak lateral overload is 1.5 g.

Key: (1). Major performance parameters of the SL-14 Tsyklon 3 carrier rocket. (2). Overall length (meters). (3). Diameter (meters). (4). Launch mass (tons). (5). Launch thrust (kN). (6). Number of stages. (7). Low earth orbit carrying capacity (kilograms). (8). Launch cost (in tens of thousands of U.S. dollars). (9). Time of first launch (year, month, day). (10). First stage. (11). Engine type. (12). Propellant. (13). UDMH/NTO. (14). Propellant mass (tons). (15). Sea level average thrust (kN). (16). 2747 (includes verniers). (17). Sea level specific impulse (newtons•seconds/kilograms). (18). (Unknown). (19). Burn time (seconds). (20). Second stage. (21). RD-219 (possibly modified). (22). Vacuum average thrust (kN). (23). Vacuum specific impulse (newtons•seconds/kilograms). (24). Third stage. (25). Fairing height (meters). (26). Fairing diameter (meters). (27). Guidance system. (28). Strapped-down inertial guidance.

The SL-14 Tsyklon 3 carrier rocket uses strapped-down inertial control methods, and the vernier rockets on the first and second stages provide three-axis control. This rocket was launched for the first time from the Plesetsk launching site on June 24, 1977, and has been in

service continuously for 18 years. Figure 2 shows a schematic diagram of its structure, and Table 1 lists its major performance parameters.

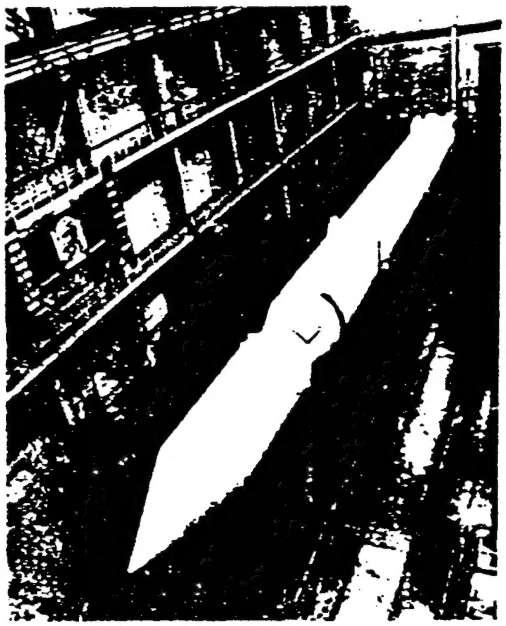


图 3 旋风 3 在总装厂房内

Key: Figure 3 Tsyklon 3 in general assembly plant.

The Tsyklon is a medium-sized carrier rocket. The SL-11 Tsyklon 2 can send a three-ton payload into a 65 degree inclination low earth orbit,

while the SL-14 Tsyklon 3 can send a four-ton payload into a 65 – 82.5 degree inclination low earth orbit. Tsyklon launches account for 10 percent of all space launches by the former Soviet Union/CIS. Early on, the SL-10 and SL-11 were used as tools for carrying former Soviet outer space weapons, and later primarily for launching radar/electronic intelligence ocean surveillance satellites. All were launched from the Baikonur launching site. By the end of 1993, these two types of rockets were launched 129 times with 121 successful launches, for a success rate of 93.8

percent. After the SL-14 went into service, many payloads that were originally prepared to be launched by Cosmos or Vostok were instead launched by it. Its range of payloads includes electronic reconnaissance satellites, weather satellites, remote sensing satellites, communications satellites, oceanographic satellites, geodetic satellites, scientific exploration satellites, and other small military satellites, with military payloads most numerous. Up to now, SL-14 carrier rockets have all been launched from the Plesetsk launching site in northwestern Russia, but theoretically, because the first two stages of the SL-11 and the SL-14 are the same, the SL-11 facilities at Baikonur could also be used to launch the SL-14. By August 1994, the SL-14 Tsyklon 3 was launched 112 times with 107 successes, for a success rate of 95.5 percent. Figures 3 and 4, respectively, show the SL-14 in the general assembly plant and on the launch pad. Figures 5 and 6 are schematic diagrams of its flight routines.

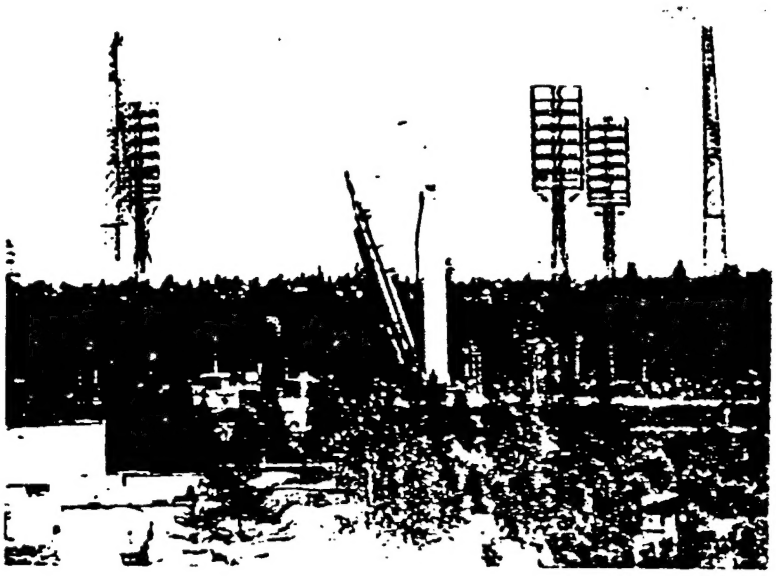
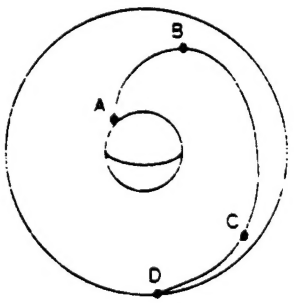


图4 旋风3在发射台上

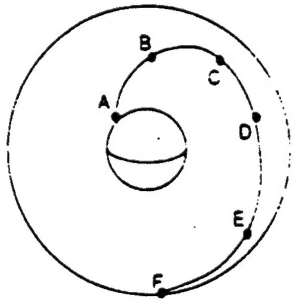
Key: Figure 4 Tsyklon 3 on launch pad

In October 1987, on the 30th anniversary of the launching of the first artificial earth satellite, the former Soviet Union announced that the Tsyklon 3 could provide commercial launching services to foreign customers. It was only at this time that pictures of and data on the

Tsyklon 3 began to be revealed to the outside world. The cost announced was U.S. $10 million per launch. The Tsyklon 3 is a very competitive commercial carrier rocket when considered from the aspects of performance, safety and reliability levels, and launch price, but because of the effects of the Cold War, it still hasn't attracted any real customers. After the end of the Cold War and the disintegration of the Soviet Union, new contradictions arose between the Ukrainian production factory and the primarily Russian management and usage units. These have all had detrimental effects on Tsyklon's successful entry into the commercial launch market. Despite this, on August 31, 1993 and January 25, 1994 respectively, when launching Meteor series meteorological satellites, it also carried and launched an Italian satellite (Temisat) and a German satellite (Technical University of Berlin satellite B [Tubsat B]), thus taking its first step into the commercial launch market.



① 图5 SL-14火箭飞行程序示意(第三级单次工作)(图中:AB—第一、二级主动飞行段,约280秒;BC—第三级惯性飞行段,不短于40秒;CD—第三级点火飞行段,5~118秒)



② 图6 SL-14火箭飞行程序示意(第三级两次工作)(图中:AB—第一、二级主动飞行段,约280秒;BC—第三级第一次惯性飞行段,不短于40秒;CD—第三级第一次点火飞行段,5~113秒;DE—第三级第二次惯性飞行段,不短于150秒;EF—第三级第二次点火飞行段,5~113秒)

Key: (1). Figure 5 SL-14 rocket flight sequence diagram (third stage single operation) (In the figure, AB is the first and second stages' powered-flight phase, approximately 280 seconds; BC is the third stage's inertial flight phase, no less than 40 seconds; and CD is the third stage's ignition flight phase, 5 to 118 seconds.)

(2). Figure 6 SL-14 rocket flight sequence diagram (third stage dual operation) (In the figure, AB is the first and second stages' powered-flight phase, approximately 280 seconds; BC is the third stage's first inertial flight phase, no less than 40 seconds; CD is the third stage's first ignition flight phase, 5 to 113 seconds; DE is the third stage's second inertial flight phase, no less than 150 seconds; and EF is the third stage's second ignition flight phase, 5 to 113 seconds.)